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REMARKS

In response to the Office Action date mailed December 14, 2004, Applicants respectfully request reconsideration. To further the prosecution of this Application, Applicants submit the following remarks, and have amended and canceled claims. The claims as now presented are believed to be in allowable condition.

Claims 1-23, 25, 30, 32, 34-37 and 39-50 were pending in this Application. By this Amendment, claims 43, 45, 47 and 49-50 have been canceled. Applicants expressly reserve all rights to pursue claims as they appeared prior to this Amendment and similar claims in one or more related Applications. Accordingly, claims 1-23, 25, 30, 32, 34-37, 39-42, 44, 46 and 48 are now pending in this Application. Claims 1, 14, 23 and 32 are independent claims.

Preliminary Matters

Applicants wish to thank Examiner Chace for the courtesies provided to Applicants' Representative, David E. Huang, during a telephone conference on February 11, 2005. Although no agreements were reached, Examiner Chace and Mr. Huang were able to review and discuss various aspects of the Application and prosecution history in an attempt to further the prosecution of this Application.

Information Disclosure Statement

In response to Applicants request to have the Patent Office complete and return Applicants' earlier-submitted PTO-1449 form which was included with Applicants Information Disclosure Statement mailed August 12, 2004, the Patent Office attached a copy of the PTO-1449 form with the references "lined out" to indicate that they have not been considered. The Office Action asserts, on page 2, that the rationale such processing is because "the submission requires a specific statement and fee pursuant to MPEP 609."

Applicants' respectfully disagree with this assertion. The submission required either a specific statement *or* the fee. In particular, MPEP 609 expressly states the following:

37 CFR 1.97 Filing of information disclosure statement.

(a) In order for an applicant for a patent or for a reissue of a patent to have an information disclosure statement in compliance with § 1.98 considered by the Office during the pendency of the application, the information disclosure statement must satisfy one of paragraphs (b), (c), or (d) of this section.

(b) An information disclosure statement shall be considered by the Office if filed by the applicant within any one of the following time periods:

- (1) Within three months of the filing date of a national application other than a continued prosecution application under § 1.53(d);
- (2) Within three months of the date of entry of the national stage as set forth in § 1.491 in an international application;
- (3) Before the mailing of a first Office action on the merits; or
- (4) Before the mailing of a first Office action after the filing of a request for continued examination under § 1.114.

(c) An information disclosure statement shall be considered by the Office if filed after the period specified in paragraph (b) of this section, provided that the information disclosure statement is filed before the mailing date of any of a final action under § 1.113, a notice of allowance under § 1.311, or an action that otherwise closes prosecution in the application, and ***it is accompanied by one of:***

- (1) The statement specified in paragraph (e) of this section; or
- (2) The fee set forth in § 1.17(p). (*Emphasis added*).

Applicants information disclosure statement was submitted in full compliance with MPEP 609 and 37 CFR 1.97(c). In particular, Applicants' information disclosure statement was submitted on August 12, 2004 which was after the mailing of a first Office action and before the mailing date of a final action. Furthermore, Applicants' information disclosure statement was submitted with the fee set forth in § 1.17(p).

A copy of Applicants' information disclosure statement and the PTO-1449 form is enclosed with this Amendment. The portion of the information disclosure statement showing payment of the fee set forth in § 1.17(p) is highlighted. In particular, 37 CFR 1.25 provides for payment of fees using a deposit account

"[f]or the convenience of attorneys, and the general public in paying any fees due...."

In view of the above, the Patent Office must properly process the information disclosure statement by considering the references and returning a completed PTO-1449 showing that the disclosed references are now of record in the Application. Without properly processing the information disclosure statement as described above, Applicants' would not be able to respond to the correspondences from the Patent Office in a reliable manner. Accordingly, Applicants again respectfully request that the Patent Office consider the disclosed references and return a completed PTO-1449 form with the next Patent Office correspondence.

Claim Objection

Claim 42 was objected to due to a minor informality. Applicants have made a clarifying amendment to claim 42 to correct this informality. Accordingly, the objection to claim 42 should be withdrawn.

Rejections under §102 and §103

Claims 1-23, 25, 30, 32, 34-37 and 43-50 were rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 5,805,787 (Brant et al.). Claims 39-42 were rejected under 35 U.S.C. §103 (a) as being unpatentable over Brant et al. in view of U.S. Patent No. 5,195,100 (Katz et al.).

Applicants respectfully request reconsideration of claims 43, 45, 47 and 50. In order to further the prosecution of this Application, Applicants have amended independent claims 1, 14, 23 and 32 to include the limitations of claims 43, 45, 47 and 50 (claim 50 includes claim 49), respectively, and then canceled claims 43, 45, 47 and 49-50. There were no amendments made to the Application that would require the Patent Office to perform further searching and/or consideration upon entrance of this Amendment since claims 43, 45, 47 and 50 were under consideration prior to this Amendment and since Applicants

have taken great care not to include any limitations other than those of claims 43, 45, 47 and 50.

The claims are in allowable condition because they patentably distinguish over the cited prior art. A detailed explanation now follows.

Brant discloses an array of relatively slow devices, such as low cost disk drives, with the data replicated across those devices so as to enhance the probability that one of the read/write heads is relatively close to the desired data upon the occurrence of a read command (see column 2, lines 38-43 and Fig. 1). The controller renders a logical decision as to which drive can produce the desired data with the least delay (see column 2, lines 43-45). Brant further discloses a storage hierarchy associated with various contemporary storage configurations which appears as follows in order of highest cost but fastest performance first and lowest cost but slowest performance last:

1. The registers of a Microprocessor;
2. An on-chip cache;
3. An off-chip cache;
4. Main memory;
5. I/O buffers;
6. A solid state disk cache;
7. A disk based disk cache;
8. A high performance disk;
9. A high capacity disk;
10. Slower high capacity disks; and
11. Optical, tape and/or library (see column 5, lines 11-28).

A storage subsystem that has the MB cost of disk coupled with the performance of many disks operating in parallel can fill several intermediate slots in this hierarchy (see column 5, lines 29-31). Spin synchronizing of the disks can help keep disk access times relatively low (see column 5, lines 31-33). Further down the hierarchy, inexpensive controllers coupled to an array in RAID1 configurations can yield high I/O rates (see column 5, lines 33-35). Disks 53-58 are the disks of the disk based disc cache interfacing system, while other disks shown in array 22 might actually provide the disk storage devices for disk

subsystem 25 possibly under the supervision of another controller (see column 6, lines 20-28 and Fig. 4). Conversely, an entirely separate high capacity data storage device can independently provide the subsystem 25 functions (see column 6, lines 29-31). Array 22 is made of a multiplicity of small disk drives which can encompass both a disk cache array 50 and, if desired, the disks of mass storage system 25 in Fig. 1 (see column 6, lines 55-58).

Pages of The RAID book (TRB) disclose a variety of RAID levels (see pages xv through xvii). Additionally, pages of TRB disclose cold swap, warm swap, hot swap and automatic swap in order to substitute a replacement unit in a storage system for a defective one (see pages 50-51). Furthermore, the TRB discloses that the ANSI X3T10 SCC disk array model requires extent stripe depth to be constant (see page 63).

Katz discloses a multiple storage device mass storage system (see column 4, lines 21-24). Some, and preferably all, of the information is loaded into nonvolatile memory 413 before the start of any write operation (see column 12, lines 17-52).

Claims 1-13, 25, 39 and 44

Claim 1 was amended to include all of the limitations of claim 43, and then claim 43 was canceled. Applicants have not made any other amendment to claim 1. Accordingly, Applicants have not amended the claims in a manner that would require the Patent Office to provide further searching and/or consideration. Rather, as a matter of right, Applicants simply request reconsideration of the allowability of claim 43 which is now embodied as an independent claim in claim 1.

Claim 1, as amended, is directed to a cache including a front-end interface that receives data access requests that specify respective data storage addresses, a back-end interface that can retrieve data identified by the data storage addresses, cache storage formed by at least two disks, and a cache manager that services at least some of the requests received at the front-end

interface using data stored in the cache storage. The cache manager is configured to receive a write request to store data and, in response to the write request, split that data into data portions and separately store the data portions on respective disks of the cache storage. The cache manager is further configured to receive a read request to read the data and, in response to the read request, concurrently read the data portions which are separately stored on the respective disks of the cache storage to retrieve the data. The cache storage is configured to provide, as an initial caching capacity of the cache storage, a first cache storage size. The cache storage is configured to provide, as a subsequent caching capacity of the cache storage, a second cache storage size in response to addition of a new disk to the cache storage, the second cache storage size being larger than the first cache storage size.

Brant does not disclose a cache including cache storage formed by at least two disks where the cache storage is (i) configured to provide, as an initial caching capacity of the cache storage, a first cache storage size, and (ii) further configured to provide, as a subsequent caching capacity of the cache storage, a second cache storage size in response to addition of a new disk to the cache storage, the second cache storage size being larger than the first cache storage size, as recited in claim 1. In particular, even if one were to argue that Brant's array 22 is the "cache storage" recited in claim 1, Applicants still cannot find any mention of the array 22 being configured to provide "a first cache storage size" and "a second cache storage size in response to addition of a new disk to the cache storage, the second cache storage size being larger than the first cache storage size," as recited in claim 1.

Moreover, Applicants wish to respectfully point out that the Patent Office's reasoning for rejecting claim 43 is incorrect. In particular, the reasoning still does not identify every element of the claim in the cited prior art. Furthermore, the teachings of the newly cited TRB reference have been mis-characterized. This will be explained in further detail below.

"A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference."¹ "The identical invention must be shown in as complete detail as is contained in the ... claim."²

In the Office Action's rejection of claim 43 (see the last paragraph of page 19 through the first paragraph of page 20), the Office Action states the following in connection with the Brant array:

Lines 20-30 and 55-57 discuss the fact that some or all of the disks in the array may be used as a cache. If some of the disks are used as the cache, then the cache size would be (total # of disks) - (mass storage disks) = first cache storage size. This size would be smaller than if all the disks were used as a cache, which would be the claimed first cache storage size.

Even if one were to successfully argue that these statements are correct regarding Brant, there is still not showing of providing a second cache storage size in response to addition of a new disk to the cache storage, the second cache storage size being larger than the first cache storage size, as recited in claim 1.

Brant does not teach providing a second cache storage size in response to addition of a new disk. Rather, Brant simply discloses an array in which some disks 53-58 are the disks of a disk based disc cache interfacing system, while other disks shown in array 22 might actually provide the disk storage devices for disk subsystem 25 possibly under the supervision of another controller (see column 6, lines 20-28 and Fig. 4 of Brant). Conversely, in Brant, an entirely separate high capacity data storage device can independently provide the subsystem 25 functions (see column 6, lines 29-31 of Brant). Furthermore, the Brant array 22 is made of a multiplicity of small disk drives which can encompass both a disk cache array 50 and, if desired, the disks of mass storage system 25 in Fig. 1 (see column 6, lines 55-58 of Brant). Accordingly, it should be clear

¹ *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).

² *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989).

that, in Brant, there is no mention of adding a disk to modify the size of the Brant disk based disc cache.

The Office Action goes on to state that:

In addition, examiner has cited as extrinsic evidence of the capacity of an array changing, TRB pages 50-51, which discusses the swapping methods employed in RAID systems such as the RAID 3 system cited in Brant et al. Also, see mention of "configured to" language addressed supra.

Applicants respectfully submit that this contention is wrong. Pages 50-51 of TRB do not provide extrinsic evidence of the capacity of an array changing on TRB pages 50-51. To the contrary, pages of TRB disclose cold swap, warm swap, hot swap and automatic swap in order to substitute a replacement unit in a storage system for a defective one (see pages 50-51 of TRB). In the provided pages of TRB, there is no mention of a change in capacity whatsoever or any reason to think that there would be a benefit to changing the capacity when substituting a replacement unit in a storage system for a defective one. If anything Furthermore, the TRB discloses that the ANSI X3T10 SCC disk array model requires extent stripe depth to be constant (see page 63 of TRB) thus implying that a defective unit should be replaced with one of the same capacity.

In connection with Applicants use of the language "configured to", Applicants use of this claim language is definite and has a limiting effect. However, for the reasons stated above, there is clearly no showing that the cited prior art is "configured to" as recited in claim 1. Furthermore, nothing in Katz (prior art of record which was cited in the rejection of claim 39) teaches or suggests how one could modify Brant to provide all of the limitations of claim 43 (now embodied in claim 1).

For the reasons stated above, claim 1 patentably distinguishes over the cited prior art, and the rejection of claim 1 under 35 U.S.C. §102(b) should be withdrawn. Accordingly, claim 1 is now in allowable condition.

Because claims 2-13, 25, 39 and 44 depend from and further limit claim 1, claims 2-13, 25, 39 and 44 are in allowable condition for at least the same reasons. Additionally, it should be understood that the dependent claims recite additional features which further patentably distinguish over the cited prior art.

For example, claim 44 (which has been amended to depend directly from claim 1 rather than claim 43 which has been canceled) recites the cache manager, when responding to the read request, is configured to:

- (i) receive the read request from ***another cache device connected to the cache in series as part of a cache hierarchy*** in response to a cache miss at the other cache device, the cache miss involving a failure of the other cache device to provide cached data corresponding to an address of the cache storage;
- (ii) obtaining the data portions which are separately stored on the respective disks from the cache storage in response to the read request; and
- (iii) providing the obtained data portions to the other cache device to satisfy the read request.

This clearly involves the use of a cache hierarchy with cache devices connected in series. There is no teaching of such a cache hierarchy with cache devices connected in series in Brant.

In the rejection of claim 44, the Office Action contends the following (see page 20 middle paragraph of the Office Action):

With respect to claims 44, 46, and 48, receiving a request from another cache device connected to the cache in series as part of a cache hierarchy in response to a cache miss at the other cache device is disclosed in column 4, lines 17-24 [of Brant], which discusses the hierarchical known nature of a hierarchical storage system. The cache miss involving a failure of the other cache device to provide cached data corresponding to an address of the cache storage is disclosed in column 4, lines 34-48, which discuss that if the data is not in the disk cache, then the data is transferred from the subsystem, and stored in the array as well as returned to the host. Again, this hierarchical nature is discussed in column 5, as cited and discussed supra, which states that the Brant et al array can fit into several intermediate slots in the hierarchy shown - not just ONE slot, but SEVERAL.

This is a clear mis-characterization of the teachings of Brant. Brant does not disclose in column 4, lines 17-24 "receiving a request from another cache device connected to the cache in series as part of a cache hierarchy in response to a cache miss at the other cache device" as contended by the Office Action. Rather, column 4, lines 17-24 of Brant simply hierarchically lists various contemporary storage configurations in order of highest cost but fastest performance first and lowest cost but slowest performance last. Moreover, it is unclear why one would ever want to connect the elements of the Brant list in series as part of a cache hierarchy. Brant's mention of "[a] storage subsystem that has the MB cost of disk coupled with the performance of many disks operating in parallel can fill several intermediate slots in this hierarchy," (see column 5, lines 29-31 of Brant) clearly refers to cost/performance relationship of the Brant system relative to other listed types of caches and not a physical arrangement.

Accordingly, Brant does not disclose the invention as recited in claim 44. If the rejection of claim 44 is to be maintained, Applicants respectfully request that it be pointed out with particularity where the cite prior art teaches "another cache device connected to the cache in series as part of a cache hierarchy" as recited in claim 44.

Claims 14-22, 40 and 46

Claim 14 was amended to include all of the limitations of claim 45, and then claim 45 was canceled. Applicants have not made any other amendment to claim 14. Accordingly, Applicants have not amended the claims in a manner that would require the Patent Office to provide further searching and/or consideration. Rather, as a matter of right, Applicants simply request reconsideration of the allowability of claim 45 which is now embodied as an independent claim in claim 14.

Claim 14, as amended, is directed to a method of servicing data access requests at a cache. The method includes receiving the data access requests at

the cache. The cache has cache storage formed by at least two disks. The requests specify respective data storage addresses. The method further includes servicing at least some of the requests using data stored in the disks. Receiving the data access requests includes receiving a write request to store data. Servicing at least some of the requests includes splitting that data into data portions and separately storing the data portions on respective disks of the cache storage in response to the write request. Receiving the data access requests further includes receiving a read request to read the data. Servicing at least some of the requests further includes concurrently reading the data portions which are separately stored on the respective disks of the cache storage to retrieve the data in response to the read request. The cache storage is configured to provide, as an initial caching capacity of the cache storage, a first cache storage size. The method further includes adding a new disk to the cache storage to provide, as an subsequent caching capacity of the cache storage, a second cache storage size, the second cache storage size being larger than the first cache storage size.

The cited prior art does not teach a method of servicing data access requests at a cache having cache storage formed by at least two disks where the method includes adding a new disk to the cache storage to provide, as a subsequent caching capacity of the cache storage, a second cache storage size, the second cache storage size being larger than a first cache storage size, as recited in claim 14. Rather, as explained above in connection with claims 1 and 43, Brant does not teach providing a second cache storage size in response to addition of a new disk. Moreover, as explained above in connection with claims 1 and 43, the Office Action improperly rejects claim 43 due to incorrect reasoning and incorrect characterization of the prior art.

For the reasons stated above, claim 14 patentably distinguishes over the cited prior art for at least the same reasons as claims 1 and 43. Accordingly, the rejection of claim 14 under 35 U.S.C. §102(b) should be withdrawn, and claim 14 is now in allowable condition.

Because claims 15-22, 40 and 46 depend from and further limit claim 14, claims 15-22, 40 and 46 are in allowable condition for at least the same reasons. Additionally, it should be understood that the dependent claims recite additional features which further patentably distinguish over the cited prior art.

For example, claim 46 (which has been amended to depend directly from claim 14 rather than claim 45 which has been canceled) recites limitations similar to that of dependent claim 44 which depends from claim 1. Accordingly, arguments similar to those set forth above in connection with claim 44 apply to claim 46.

Claims 23, 30, 41 and 48

Claim 23 was amended to include all of the limitations of claim 47, and then claim 47 was canceled. Applicants have not made any other amendment to claim 23. Accordingly, Applicants have not amended the claims in a manner that would require the Patent Office to provide further searching and/or consideration. Rather, as a matter of right, Applicants simply request reconsideration of the allowability of claim 47 which is now embodied as an independent claim in claim 23.

Claim 23, as amended, is directed to a data storage system including a back-end storage system having an address space. Addresses in the address space identify blocks of storage. The data storage system further includes a cache for the back-end storage system having a lesser storage capacity than the back-end storage system. The cache includes a front-end interface that receives I/O (Input/Output) requests that specify respective addresses of back-end storage blocks, a back-end interface that communicates with the back-end storage system, cache storage formed by at least two disks having platter diameters less than 3.5 inches, and a cache manager that services at least some of the I/O requests received via the front-end interface using blocks temporarily stored in the cache storage. The cache manager is configured to receive a write request to store data and, in response to the write request, split that data into

data portions and separately store the data portions on respective disks of the cache storage. The cache manager is further configured to receive a read request to read the data and, in response to the read request, concurrently read the data portions which are separately stored on the respective disks of the cache storage to retrieve the data. The cache storage is configured to provide, as an initial caching capacity of the cache storage, a first cache storage size. The cache storage is further configured to provide, as a subsequent caching capacity of the cache storage, a second cache storage size in response to addition of a new disk to the cache storage. The second cache storage size is larger than the first cache storage size.

The cited prior art does not teach a data storage system including a cache having cache storage formed by at least two disks having platter diameters less than 3.5 inches, where the cache storage is configured to provide, as a subsequent caching capacity of the cache storage, a second cache storage size in response to addition of a new disk to the cache storage, the second cache storage size being larger than the first cache storage size, as recited in claim 23. Rather, as explained above in connection with claims 1 and 43, Brant does not teach providing a second cache storage size in response to addition of a new disk. Moreover, as explained above in connection with claims 1 and 43, the Office Action improperly rejects claim 43 due to incorrect reasoning and incorrect characterization of the prior art.

For the reasons stated above, claim 23 patentably distinguishes over the cited prior art for at least the same reasons as claims 1 and 43. Thus, the rejection of claim 23 under 35 U.S.C. §102(b) should be withdrawn, and claim 23 is now in allowable condition.

Because claims 30, 41 and 48 depend from and further limit claim 23, claims 30, 41 and 48 are in allowable condition for at least the same reasons. Additionally, it should be understood that the dependent claims recite additional features which further patentably distinguish over the cited prior art.

For example, claim 48 (which has been amended to depend directly from claim 23 rather than claim 47 which has been canceled) recites limitations similar to that of dependent claim 44 which depends from claim 1. Accordingly, arguments similar to those set forth above in connection with claim 44 apply to claim 48.

Claims 32, 34-37 and 42

Claim 32 was amended to include all of the limitations of claim 50, and then claims 49 and 50 were canceled. Applicants have not made any other amendment to claim 32. Accordingly, Applicants have not amended the claims in a manner that would require the Patent Office to provide further searching and/or consideration. Rather, as a matter of right, Applicants simply request reconsideration of the allowability of claim 50 which is now embodied as an independent claim in claim 32.

Claim 32, as amended, is directed to a data storage system including a back-end storage system having a back-end address space. Addresses in the address space identify blocks of storage. The data storage system further includes a plurality of caches for the back-end storage system. Each of the plurality of caches has a lesser storage capacity than the back-end storage system. Each of the plurality of caches includes a front-end interface that receives I/O (Input/Output) requests that specify respective addresses of back-end storage blocks, a back-end interface capable of communicating with one of back-end storage system and another of one of the plurality of caches, cache storage formed by at least two disks (the cache storage having a respective cache storage address space), and a cache manager that services at least some of the I/O requests received via the front-end interface using blocks temporarily stored in the data storage system. At least some of the I/O requests correspond to addresses in the respective cache storage address space of at least some of the plurality of caches. The cache manager is configured to receive a write request to store data and, in response to the write request, split

that data into data portions and separately store the data portions on respective disks of the cache storage. The cache manager is further configured to receive a read request to read the data and, in response to the read request, concurrently read the data portions which are separately stored on the respective disks of the cache storage to retrieve the data. The cache storage is configured to provide, as an initial caching capacity of the cache storage, a first cache storage size. The cache storage is further configured to provide, as a subsequent caching capacity of the cache storage, a second cache storage size in response to addition of a new disk to the cache storage, the second cache storage size being larger than the first cache storage size.

The cited prior art does not teach a data storage system including a plurality of caches, each cache having cache storage formed by at least two disks, the cache storage being configured to provide, as a subsequent caching capacity of the cache storage, a second cache storage size in response to addition of a new disk to the cache storage, the second cache storage size being larger than a first cache storage size, as recited in claim 32. Rather, as explained above in connection with claims 1 and 43, Brant does not teach providing a second cache storage size in response to addition of a new disk. Moreover, as explained above in connection with claims 1 and 43, the Office Action improperly rejects claim 43 due to incorrect reasoning and incorrect characterization of the prior art.

For the reasons stated above, claim 32 patentably distinguishes over the cited prior art for at least the same reasons as claims 1 and 43. Thus, the rejection of claim 32 under 35 U.S.C. §102(b) should be withdrawn, and claim 32 is now in allowable condition.

Because claims 34-37 and 42 depend from and further limit claim 32, claims 34-37 and 42 are in allowable condition for at least the same reasons.

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Conclusion

In view of the foregoing remarks, this Application should be in condition for allowance. A Notice to this affect is respectfully requested. If the Examiner believes, after this Amendment, that the Application is not in condition for allowance, the Examiner is respectfully requested to call the Applicants' Representative at the number below.

Applicants hereby petition for any extension of time which is required to maintain the pendency of this case. If there is a fee occasioned by this response, including an extension fee, that is not covered by an enclosed check, please charge any deficiency to Deposit Account No. 50-0901.

If the enclosed papers or fees are considered incomplete, the Patent Office is respectfully requested to contact the undersigned collect at (508) 366-9600, in Westborough, Massachusetts.

Respectfully submitted,



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